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# NEW VARIETIES OF CROPS FOR THE NONCHERNOZEM ZONE AND METHODS OF BREEDING THEM

E. T. Varenitsa

Army Biological Laboratories
Frederick, Maryland

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DEPARTMENT OF THE ARMY
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Frederick, Maryland

NEW VARIETIES OF CROPS FOR THE NONCHERNOZEM ZONE AND METHODS OF BREEDING THEM

- USSR -

/Following is a translation of an article by Professor Ye. T. Varenitsa, Corresponding Member of VASKhNIL (All-Union Academy of Agricultural Sciences imeni Lenin), Scientific-Research Institute of Agriculture in the Nonchernozem Zone, in the Russian-language periodical Vestnik Sel'skoy Nauki (Herald of Agricultural Science), No 4, 1965, pages 60-70./

Introduction of heavy-producing varieties of agricultural crops, that respond well to organic and mineral fertilizers, into collective farm and state farm production plays a vast role in the expansion of agriculture. More than 20 varieties developed at the Institute of Agriculture in the Central Rayons of the Nonchernozem Zone, have been released to different rayons and extend over hundreds of thousands of hectares. Within the past four to five years alone, a number of new and valuable varieties of winter and spring wheat winter rye, pea, barley and other crops, eight of which have been assigned to different rayons, have been created. The rapid and extensive adoption of these varieties by collective and state farms will permit an increase in the yield of grain crops within the next few

years. In order to achieve a marked increase in grain yield, much attention must be devoted to expansion of sowing winter crops, particularly of wheat which is the most productive grain crop in the nonchernozem zone.

The variety becomes an important factor in order to achieve a high yield of winter wheat. The new varieties must have a number of agriculturally and biochemically valuable signs and properties: a high productivity must be combined with adequate winter hardiness and resistance to drought and to being beaten down, immunity to fungus diseases, good flour-milling and baking qualities in the grain and responsiveness to organic and mineral fertilizers.

By hybridizing geographically remote varieties, taking into consideration the selectivity of plants in the process of pollination, we have created a new variety of winter wheat, Kuntsevskaya 45, which was released to rayons in the Moscow oblast in 1960, in Tul'skaya oblast in 1963, and in Bryanskaya oblast in 1964. This variety is being submitted to extensive tests in state strain-testing stations as well as in collective and state farms in other oblasts both within the nonchernozem zone and beyond its limits.

In the hybridization work with winter wheat at the Institute, along with intraspecies hybridization, there is extensive use of the method of remote hybridization on the basis of crossing wheat with couch grass /agropyron repens/. A number of varieties of winter wheat, three of which are released to specific rayons and widely distributed in production have been developed in the Laboratory of Wheat-Couch Grass Hybrids. They include: PPG 186, 599 and No 1, released to rayons in 1949-1953. At the present time, the breeder G. D. Lapchenko from this laboratory has created a new hybrid material which is more valuable than the regionalized wheat-couch grass hybrids. Two numbers, 702 and 99, have been transmitted to a state strain-testing station.

Recently there has been expansion of work in the laboratory toward creating a variety with exceptional

winter hardiness and high quality of grain. This problem is being solved by three generic crossings: wheat X couch grass X rye, as well as by hybridization of rye-wheat amphidiploids with intermediate wheat-couch grass hybrids, the grain of which contains from 18 to 24 percent protein. In the fourth generation, we obtained varieties with a wheat type of spike, and grain with a high protein content. From this material, varieties are selected which have a group of agriculturally and biologically valuable signs and properties.

The Laboratory of Wheat-Couch Grass Hybrids, along with remote hybridization, is working on a rather broad scale for the past seven years, toward creating initial material for hybridization by using ionizing radiation. Seeds of PPG 186, No 1, No 99 and others were used as the initial material. Irradiation was delivered from a source of $Co^{60}$ gamma rays in doses of 10, 15 and 20 thousand roentgens. In 1958, analysis of second generation plants, obtained by irradiating the seeds of wheat-couch grass hybrids, revealed a great diversity of forms. A comprehensive examination of the new mutations revealed that erectoid and large-spiked forms, resistant to fungus diseases, presented the greatest interest from the standpoint of selection and hybridization.

It is also of interest to note that field observations and laboratory analysis revealed that morphologically homogeneous families of mutants were heterogeneous with respect to a number of biological signs and properties, which was the reason for making selection from the progeny of mutants with practically valuable forms. The most promising of these, Erectoid 72, was sown in 1962 at a competitive strain testing event. However, it did not survive the winter of 1962-1963 and was completely lost. The best families, selected from Erectoid 72, which were investigated in a testing nursery, showed different reactions to that same winter.

One of them revealed preservation of 55 to 60 percent of the plants by spring, two others died off completely. Work with selected specimens of Form No 72 and

other mutants, is now in progress by breeder G. D. Lapchenko. In the last few years as a source of irradiation, he has used gamma rays, fast neutrons and a chemical mutagen, ethylenimine. A significant diversity of forms has been obtained, now being studied in the process of selection.

The Institute is also continuing its work with winter rye. The breeding of this crop is being done by the method of hybridization of geographically remote forms with minimal free pollination; generally, local varieties are used as the maternal forms, and varieties of the Petkus type with a short and sturdy stalk are used as the paternal components. A long stalk is the dominant sign in breeding rye. In order to obtain hybrids altered in the direction of shorter stalks, saturated crossing is used. Breeder F. T. Kondratenko has been using this method to create several promising varieties of rye in the past few years. Of them, variety Hybrid 2 is grown in rayons of Moskovskaya and Yaroslavskaya oblasts, and Nemchinovskaya 56 is being tested at state strain-testing centers. These varieties differ from the existing crops by heavy productivity and resistance to being beaten down; they yield three to five centners per hectare more grain than the standard varieties.

In the breeding of rye, the method of vegetative hybridization is also being used, with which a hybrid was obtained from winter rye, Vyatka Moskovskaya (graft) and winter wheat PPG 186 (stock). It has a short and sturdy stalk, an awnless or semi-awned spike, and oval grain, resembling wheat grain. This new form of rye is used in the breeding process. By means of hybridization of vegetative hybrids with short-stalked varieties, new breeding material has been created which reveals the promise of a new short-stalked unbending variety of rye for the central rayons of the nonchernozem zone within the next few years.

In the rye breeding process the method of controlled alteration of the hereditary nature of plants is also used. By means of early winter or autumn sowing, spring Petkus rye was transformed into a winter form which

yielded an average crop of 36.6 centners over a four-year period, and exceeded the standard, Vyatka Moskovskaya, by 2.3 centners per hectare. This new variety is very hardy in the winter, and surpasses the standard with respect to resistance to being beaten down. It was found that by cultivating the first hybrid generation in the spring, the prevernalized seeds of the hybrid developed according to the recessive sign: short stalk, whereas when they were cultivated in the fall they produced a long-stalked progeny. This permitted using the method of transformation not only for direct conversion of persistent forms but also on a more extensive scale, in breeding hybrids for the purpose of regulating the form-producing process.

Of significant interest are the works of the Laboratory for Leguminous Crops of the Institute for selective breeding of new forms of perennial lupine. It is known that the main shortcomings of annual lupine was their late maturation time and low reproduction coefficient. Perennial lupine in contrast to the annual, has fine seeds with an absolute weight of only 20 to 25 grams. These forms mature in July, when the weather conditions in the rayons of the nonchernozem zone are favorable for obtaining seeds with high planting qualities. The standard yield in pure cultures of such lupine is not high: 20 to 25 kilograms, but the existing forms of perennial lupine, when planted in the spring, are barren for the first year and hibernate in the form of rosettes near the root. They yield seeds only in the second year.

Investigations conducted by A. G. Bykovtsev, candidate of Agricultural Sciences, directed toward creating forms of perennial upine with spring type of development produced interesting results. After sowing perennial lupine in June, rather than in the early spring, which is the usual time, sprouting of the seeds and vernalization stage occurs at higher temperatures, it was observed that some plants began to bloom and bear fruit the year they were planted, in late autumn. The selection of such plants and subsequent transplantation over a period of several years during the usual sowing time, and later on at earlier dates, and, finally, early in the spring, made it possible

to obtain a large quantity of plants that bloomed and matured the year they were sown. And, what is very important, the alkaloid content of these forms was much lower than in the ordinary forms of perennial lupine. The selection of plants over a period of several years, which were notably heavy producers with respect to yield of green mass and grain, made it possible to create heavy producing forms which mature the year of sowing. In other words, by means of controlled growing and selection, a radical transformation was made in the winter type of perennial lupine, and forms were obtained that had a perennial cycle of development of the vernal type. They were on a par with varieties of narrow-leafed annual lupine according to yield of green mass, and their coefficient of seed reproduction is 15, i.e., it is three to four times higher than in annual lupine.

Using the method of selective breeding and selection breeder A. G. Bykovets, in the Laboratory for Leguminous Crops, developed and transmitted to a state testing station a variety of perennial lupine, Nemchinoskiy undersown, which, in contrast to other varieties of perennial lupine which breaks up less, grows better sown under oats during the first year of its life and produces a high yield of seeds or green mass to be tilled in the second year.

The chief leguminous crop of the nonchernozem zone is pea, therefore, the Institute devotes much of its attention to the breeding of this crop. In addition to the previously developed and extensively cultivated variety, Moskovskaya 572, a new variety has been created in the last few years and has passed the state tests: Nemchinoskiy 766. This intervariety hybrid, obtained by crossing Viktoriya Mandorfskaya and early green No 33 (authors: A. G. Bykovets and G. A. Debelyy) was allotted to rayons in the Moskovskaya and Tul'skaya oblasts in 1964. It matures 10 to 12 days earlier than the standard, which means it can be used for sowing to seed in utilized fallows.

The main method of breeding pea in the Institute is hybridization of geographically remote forms. Heavy

producing varieties having developmental stages of varied duration are selected for the crossing. To produce breeds resistant to being beaten down, dwarf forms and short-stalked varieties are used.

In addition, the Laboratory for Leguminous Crops (G. A. Debelyy) uses various physical and chemical mutagens in order to obtain new initial material in breeding work with the pea. For this purpose the seeds are irradiated with gamma rays, fast neutrons or else they are soaked in solutions of dimethyl sulfate; other reagents are also used. During cultivation of the seeds that have been exposed to physical and chemical mutagenic factors, a significant number of plant forms were obtained in the second and following generations differing from the initial variety in morphological and biological signs. It was noted that the variability of varieties, depending on their origin, varied in the presence of equal doses and variants of agents. In some cases the types of mutation were specific for a particular variety under the influence of different variants of chemical and physical mutagens. For example, the variety Kapital, in contrast to others in all variants of agents, had a large number of mutants, the peas of which have a weak parchment layer. The number of mutations constituted 3.5 to 4.8 percent following gamma ray irradiation of Moskovskiy 572, Kapital, and Nemchinovskiy 51 varieties of pea. Irradiation of Nemchinovskiy 51 with thermal neutrons resulted in 3.1 to 8.5 percent altered forms, depending on the tension of the agent. Treatment of the seeds with diethylsulfate resulted in a variable number of altered forms, depending on the variety, ranging from 2.3 to 13.1 percent. It must be noted that 10 to 25 percent of the obtained mutants, and up to 50 percent when the dosage of physical mutagens was increased, consisted of sterile and semi-sterile forms.

At the present time, it is still premature to evaluate the forms obtained by the above methods of using physical and chemical factors with respect to direct selection, but some of them may be of interest for hybridization.

The Institute is conducting work on a rather large scale toward breeding spring wheat, barley, oats and buckwheat. This work is supervised by senior breeder, Professor V. Ye. Pisarev, who is in charge of the Laboratory of Spring Grain Crops and Polyploids. He developed a variety of spring wheat, Moskovka, by crossing Tulun 70 B/8 X Kitchener; along with a heavy productivity this new variety is resistant to fungus diseases and has good flour milling and baking qualities in the grain. This variety is cultivated not only in the central rayons of the nonchernozem zone, but also beyond its boundaries. However, along with its good qualities, it has a tendency toward sprouting on the root. Therefore, Professor V. Ye. Psarev has been working toward eliminating this shortcoming. By cultivating Moskovka by late autumn, sowing forms of another variety were selected: erythrospermum. They served as the initial material for development of a new variety of spring wheat, Krasnozernaya /red-grained/. Thus, through selective alteration, red-grained forms were obtained from white-grained ones. The new variety retained all of the qualities of Moskovka, and at the same time was more productive and more resistant to sprouting at the root. In 1960, it was assigned to rayons and is now being introduced into production.

Professor V. Ye. Pisarev has been working for a long time toward developing wheat-rye hybrids with 42 and 56 chromosomes. Investigations revealed that the amphidiploids he developed have a distinctly higher protein content in the grain. Therefore, in order to improve the quality of the grain of newly developed varieties of spring wheat, amphidiploids are being crossed with wheat.

As a result of this work, several breeding specimens of hybrids have been developed and were entered at strain-testing contests. The results of tests made during the last two years revealed that two of the diploid wheat hybrids obtained from crossing Moskovka spring wheat with PPG 186 winter wheat were the most promising with respect to productivity and quality of the grain. They were superior in productivity to the Krasnozernaya variety (standard) by an average of 3.3 to 4.4 centners per hectare,

or by 12 to 15.6 percent. The best of these, both in yield and in quality of the grain, variety 14H153/14, will be transmitted to the State Commission for strain testing, if good results are obtained with it in 1965.

One of the trends in the work of the Polyploid Laboratory is to develop and select amphidiploid forms and hybrids with hardy varieties of winter wheat which could be used as selection material in Siberia and the Far East. In autumn of 1964, the Laboratory delivered a set of such forms and hybrids for sowing to 50 centers in the Eastern part of our country.

Last year work was begun on investigation and utilization of heterosis in the selection of wheat, on the basis of male cytoplasmatic sterility. The first saturation crossing of a hybrid (Bizon X Khar'kov) with male sterility was performed with 16 varieties of spring wheat and 9 of winter wheat.

In the last few years, two new varieties of spring wheat have been developed at the Institute by the method of intraspecies hybridization and selection: Nemchinovskiy, allotted to rayons since 1963, in Yaroslavskaya oblast, and Moskovskiy 121, assigned to rayons in Moskovskaya oblast in 1964. It has been rated as promising for Kalininskaya oblast and Krasnoyarskiy kray. These varieties are being submitted to extensive tests at state strain-testing stations as well as under production conditions.

Selection of buckwheat is also being performed in the Laboratory of V. Ye. Pisarev, using both intervariety hybridization and polyploidia. As a result, he has developed a variety of large grained tetraploid buckwheat which was tested at state strain-testing stations from 1953 to 1958. However, it was inferior in productivity to the existing standard, it matured later and was not exploited extensively. At the present time, there is a new promising material obtained as the result of intervariety hybridization and selection.

During the past decade, the Institute has been doing selection work with corn, for the purpose of creating early maturing varieties and hybrids capable of a high yield of cobs with mature wax and lactic-wax elements, to serve as a source not only of succulent fodder, but also of concentrated fodder. Several fast-maturing hybrids were developed (breeder, V. I. Balyura). Nemchinovskiy 2 (Early Moskovskaya X Chernovitskaya 21 line) was submitted to the most comprehensive investigation. Using the appropriate agricultural technology (with sowing by the dot method, with the rows 60 centimeters apart, and with a density of the plants of 120 thousand per hectare), the 1964 yield was about 40 centners of dry grain per hectare, in spite of droughts. This hybrid is being tested at state strain-testing stations and is undergoing production tests at state and collective farms in Moskovskaya oblast.

It has already been stated above that in 1960, a new variety of winter soft wheat, developed by the method of intraspecies hybridization with selective pollination, was allocated to rayons of Moskovskaya oblast, and in the subsequent years in other oblasts as well. Selection work toward developing the variety, Kuntsevskaya 45, was begun as early as 1945 at the Mironovskaya selection station, and from 1948 on was continued in outlying districts of Moscow. It is known that in the past 20 years, hybridization has become one of the chief methods of developing initial material for selection.

The biological advantage of cross pollination is due to the fact, as we know, that organisms obtained by cross breeding the parents, previously living under different conditions, have a greater flexibility, and better adjustment to environmental changes, in other words, they are more viable. The natural tendency of organisms toward periodic cross breeding, and the selectivity of pollination are inseparable. With cross pollination impregnation is possible not only by their own pollen, but also by that formed by the organisms, the growth and development of which took place under conditions other than those of germination of maternal forms. C. Darwin discovered the phenomenon of preferential selection provided by the pollen

of the maternal plant in the case of some pollinating plants, which he called predominance, prevalence. In developing this Darwinian position, K. A. Timiryazev also noted the presence of selectivity during impregnation. In his book, "Darwinism and Selection," it is stated . "For example, in higher plants pollen from different plants can get on the surface of a single stigma, but the results of pollination are not the result of chance, and it is always observed that there is always one competitor with some advantage over the others."

I. V. Michurin, and later on T. D. Lysenko as well, also repeatedly noted the biological benefit from the natural phenomenon of "free selection of pollen" and recommended that it be applied to plant hybridization.

On the basis of the theoretical positions on the significance of selectivity in the process of pollination, as expounded by C. Darwin and subsequently developed by Michurin, as well as of the results of our own experimental studies, we adopted hybridization associated with selective pollination as a most important method of developing new highly productive plant forms.

Observations and direct experiments revealed that, in most cases, hybrids resulting from selective pollination generally develop better, they are sturdier and straighter, hardier in the winter, more resistant to premature drying, and more productive than the hybrids resulting from forced crossing. Hybridization associated with consideration of the selectivity of gametes in the process of pollination was practiced with both free and restricted pollination.

The essence of this method is that in obtaining hybrids as maternal varieties, the best standard varieties of rayons are selected, and as a rule varieties from other zones, that could enrich the hereditary base of the maternal variety with new and valuable signs, such as high yield, hardiness, resistance to fungus disease, to being beaten down, etc., are selected as the paternal components. The pollination, following castration of the flowers of the maternal variety, is not performed forcibly, but freely,

with the help of the wind, or it is restricted by group isolators which permits the maternal variety to select the most biologically suitable pollen.

As a result of the selection work done on the basis of the above methods, a number of new promising varieties of winter wheat have been developed and are now at various test stages. One of them, Kuntsevskaya 45, as we have stated above, has already been distributed in production. It is an intervariety hybrid, the maternal component for which was Lyutestsens 17 from the Verkhnychskaya selection station. The pollinating mixture included the hardiest and most productive varieties developed in the Ukraine, in the region along the Volga, and TsChO /Central Chernozem oblasts/: Odesskaya 3, Odesskaya 12, Lesostepka 75, Stepnaya 135, Lyutestsens 329, Gostianum 237, Shmitovka 103, Alabasskaya, and some others.

The hybrid combination obtained on the basis of selective pollination of Lyutestsens 17 served as the initial material for individual familial and mass selection. In the first generation, the selection was made from the maternal type, and after assessment of the hardiest and most productive morphologically similar families in the second generation, they were combined and served as the basic new variety of winter wheat. This early maturing, highly productive variety is resistant to the winters in the outlying districts of Moscow. It is drought resistant, has grain with a high absolute weight: 50 to 60 grams, it has a high unit value: 800 to 820 grams, good flour milling and bakery qualities, it has adequate resistance to ustilago and kernel smut and to being beaten down. During a six-year period of state testing (1958-1963) at the Tul'skiy strain-testing station, it showed a yield of 32.4 centners, which was 6.1 centners above the standard Ul'yanovka, and in 1962 it had a yield of 49.6 centners per hectare, or 18 centners above that standard. At the Plavskiy strain-testing station in the same oblast, the average yield over a five-year period was 39.4 centners, which is 8.3 centners above the standard. The increment in yield of Kuntsevskaya 45 was 3.2 centners per hectare at the Gzhatskiy strain-testing station in Smolenskaya

oblast, as compared to the standard. This variety also revealed good indices at a number of other testing stations.

The results of tests under production conditions are an important factor in the assessment of new varieties. In 1963, we know that the conditions were highly adverse for the winter wheat crop. The data indicate that Kuntsevskaya 45 withstood this severe test. Thus, at the Leninets collective farm, in Bryanskiy rayon, Bryanskaya oblast, it had a yield that year of 17.2 centners, which was 4.5 centners above the yield of Lyutestsens 266 (standard), 4.7 centners above the yield of the wheat-couch grass hybrid 186, and 2.2 centners per hectare above the yield of Khar'kovskaya 4.

For three years now, Kuntsevskaya 45 is being tested at several farms in Gor'kovskaya oblast, where, as we know, the winters are more rigorous; here too, the results were good.

Extensive evaluation of the variety and reproduction of seeds at collective and state farms is being made in a number of farms even prior to allocation to rayons, concurrently with state strain testing, and as the variety begins to manifest its good qualities, the sowing areas are being expanded. Similar work is being done at the collective farms of Kurskaya, Penzenskaya and several other oblasts.

Of special interest are the results of developing a new variety at the experimental-production farm of the Ministry of Agriculture USSR. Here, a yield of 44.1 centners per hectare of Kuntsevskaya 45 has been obtained on an area extending over 62 hectares, formerly planted with corn. This is indicative of the high potentials of this variety, and they are best manifested on good soil, and favorable conditions, which are improved by intensification of agricultural production.

The results of state tests and verification of the new variety under production conditions reveal that it has a high degree of flexibility and adapts well to different

soil and climatological conditions. This is confirmed by the fact that Kuntsevskaya 45 produces a good yield not only in the vicinity of Moscow, but also in rayons where the winters are more rigorous.

Accelerated reproduction of Kuntsevskaya 45 seeds in several of the leading collective and state farms have permitted expansion of the area seeded with it in Moskovskaya oblast to almost 14 times the area involved two years ago: from 601 hectares in 1963 to 8,149 hectares for the 1965 crop.

It would be desirable to convert the seed-growing system in its entirety to the production of prime seeds and to the first reproduction of a new variety, right after allocation to rayons, so that the replacement with a new variety could be effected within the shortest period of time. In this case, the old varieties should be permitted for production sowing, but without sowing by the seed growing system until there is enough seed of the new variety. It would be very useful to develop a system of subsidy for the agronomists at collective and state farms, and for the team foremen of seed growing teams and departments for the most rapid reproduction of seeds of new promising varieties of crops.

The team at the Selection Institute is persistently striving to develop even more valuable and productive varieties of winter wheat and other crops. Three new varieties of winter wheat were submitted for state testing in 1963-1964. They include Nemchinovskaya 495, which was developed by the method of hybridization with selective pollination, with subsequent training and selection of the most productive and valuable hybrid plants. Over a four-year period of competitive strain testing, this variety produced an average yield of 42.8 centners, which is 6.6 centners per hectare over the standard, wheat-couch grass hybrid 186. It is noteworthy that the new variety won first place at the competitive state test at the Institute in 1963, under rigorous winter conditions (the yield was 52.8 centners), and in 1964, which was a dry year, it produced a yield of 42.8 centners and was rated among the first three varieties.

In the last few years, the selection work being done at the Institute is using more and more the method of controlled change of spring varieties of wheat into winter varieties, under the influence of environmental cond[illegible] By means of early winter and fall sowing of spring [illegible] a winter variety of wheat was developed named Ukrainka Podmoskovnaya. Over a five-year test period, this variety produced an average yield of 44.3 centners per hectare, thus exceeding the standard, wheat-couch grass hybrid 186, by 3 centners per hectare. This variety belongs to the medium-mature group, it has large spikes and grain, it has good flour milling and bakery qualities, it is resistant to fungus diseases, particularly to kernel smut, and has satisfactory hardiness features.

At the present time, a study is being made of a number of new forms of winter wheat, obtained from spring forms, at various stages of the selection process. Among them, mention should be made of awnless (a lyutestsens variant), developed from awned spring Ukrainka (erythrospermum variant), as well as of the awnless and awned Moskovka, which are the result of selective transformation of a known variety of spring wheat, Moskovka (a grekum variant). These forms successfully combine high productivity, good grain quality, hardiness, resistance to being beaten down and to fungus disease. They hold much promise for further selection work.

Of special interest are forms of soft wheat which we have obtained as the result of transforming spring hard wheat, variety Narodnaya, into a winter form. Under conditions of abundant nutrition, to which first and particularly second generation plants of the transformed wheat were exposed, a wide diversity of forms was obtained, both with respect to variety composition (awned, awnless) and with respect to type of plant and spike. Among them, worthy of attention are forms which combined a large and multiple grained spike and short, sturdy stalk, as well as with multiple grained, ramified spike. These newly acquired features generally reveal hereditary stability. Thus, a marked change in living conditions leads to an extensive mutation process, to the creation of forms with

new signs and properties that are transmitted through heredity. It was noted that the forms with distinctly highly productive spike generally have a short, sturdy stalk, i.e., they are extemely resistant to being beaten down; these signs are correlated.

Until recently, some difficulty was involved with hibernation of spring variety plants, altered into a winter variety during the second year of the transformation with autumn sowing, in the work toward controlled transformation of spring crops into winter ones. It is generally not difficult to obtain a considerable amount of seeds of spring wheat for early winter sowing. However, subsequent sowing in the fall, at a time close to the optimum for winter crops, such sowings often failed to survive the winter. To overcome such difficulties, of definite importance in the transformation of spring crops into winter ones, is a new method of storing the plants during the winter, as used in the last few years by a number of researchers (A. A. Avakyan, O. T. Lysenko, and others). The varieties of spring wheat and other crops are sown toward the end of summer or early fall, near the optimum for winter crops. They vegetate in the field until persistent frost begins, then the well ramified plants are dug out together with the root sytem, the earth is removed from the roots, they are washed, and the plants are kept in a 10-20 percent sugar solution, then stored in snow until the spring, at a temperature of minus 5 or 6 degrees. With the appearance of spring vegetation, the experimental plants are transplanted in the field. Inasmuch as this method permits, in the very first year of the conversion process, to sow spring varieties quite early and that the plants assimilate solar energy in the fall -- which is a determining factor in producing the properties of a winter variety, it then becomes possible to transform the spring crops into winter ones, even within a single year. But, as a rule, the hereditary winter forms are developed during the second year of controlled conversion.

In the past few years, we have undertaken, on a small scale, the study of the efficacy of a new procedure for obtaining initial selection material, by sowing embryonically young, immature seeds. For this purpose, the

spikes were cut from 10 to 20 out of the varieties entered for competitive testing at the Institute, at various stages of grain formation, starting with production of the half caryopsis and ending with lactic-waxen and waxen maturity. Such seeds were used for sowing in the fall of 1962 and revealed that in the first generation (1963 crop) a certain quantity of plants was obtained from four out of 10 varieties, some morphological and physiological signs of which were very different from the initial variety. Thus, Nemchinovskaya 15, Ukrainka Podmoskovnaya, Mironovskaya 264 (erythrospermum variant) split off semi-awned and awnless forms. There also appeared a variety with a red spike (ferrugineum and milturum). Heine 7 (a lyutestsens variant) revealed semi-awned and awned forms.

A second generation was started from the plant offspring for further investigation, and very interesting results were obtained. The initial variety, Heine 7, a German breed, is noted for its square-headed medium-sized spike. The grain is rather large, farinaceous, with low protein content and poor technological properties. Among the good signs are its short stalk and resistance to being beaten down. Out of the 12 plants which differed markedly from the initial variety in the first generation, seven belonged to the erythrospermum variant. The progeny of these plants revealed unusual behavior. Three out of seven revealed a difference in morphological signs. They split off the initial lyutestsens variant, and in one of the families three plants of the ferrigineum variety appeared, i.e., there occurred a rare instance of splitting of forms with recessive signs: awns and white coloration of the spike. Four sets of progeny were constant, and retained the erythrospermum features.

All of the examined progeny differed from one another with respect to a number of signs and properties. Thus, the mean height of the plants was 88 to 115 centimeters, whereas the initial variety, planted under the same conditions, the height was 87.5 centimeters; the mean productive bushiness ranged from 4.5 to 8.7, the mean length of the spike ranged from 9.3 to 10.7 centimeters, whereas that of the original variety was 6.7 centimeters;

the weight of the grain from one spike ranged from 1.66 to 2.6 grams, versus 1.8 grams in the initial variety; the number of grains per spike ranged from 33 to 52, versus 42 in the initial variety; the weight per 1,000 grains was 42.0 to 52.7 as opposed to 46.5 in the initial variety.

Very interesting data were obtained with respect to evaluation of technological qualities of the grain in the examined progeny selected from a crop sown from embryonic young seeds of the Heine 7 variety. There was a variation in the seeds, in 1964, with respect to different indices: vitreousness of the grain: 74 to 99 percent, as opposed to 56 percent in the initial variety; protein content in the grain: 13.05 to 17.95 percent versus 12.37; duration of fermentation of dough: 39 to 169 minutes, versus 33 minutes, etc. A difference was also noted with respect to percentage of plants that survived the winter, duration of vegetation period, resistance to fungus diseases and other signs and properties.

In 1963, tests were repeated with 11 varieties, with sowing of young embryonic seeds. In the first generation (1964 crop), involving nine varieties, new plant forms of other varieties were obtained, with different morphological and physiological signs as compared to the initial variety. The greatest diversity of forms was noted with respect to variety Ul'yanovka, in which, in addition to the main, initial variety of velutinum, there appeared plants belonging to the lyutestsens, erythrospermum and milturum varieties.

Thus, by altering the diet of germinating grain embryos (when the seed begins to germinate and while young plants were growing, the plant food differed from the ordinary food, inasmuch as the endosperm of the seeds of experimental plants was not yet completely formed), under the influence of environmental factors upon plants with disturbed heredity, an active form-producing process was elicited, many new forms were developed which were quite different from the initial variety, not only with respect to morphological signs (appearance of other varieties) but also with respect to the set of biological and

economically valuable signs and properties. It is very important that some of the new forms persistently retain their type, and are constant, in the first generation. Some of the new forms were of practical interest, as initial material for selection.

Further investigation of the new forms will permit a more complete determination of their selection value, however, the data already available indicate that by using the above-mentioned method of sowing embryonic new seeds it is possible to elicit an active form producing (mutation) process, and to use it as one of the means of obtaining initial material.

As can be seen from the foregoing, the Institute is performing large-scale selection of several important agricultural crops: winter wheat, rye, spring wheat, barley, corn, pea, lupine, etc. Various selection methods and approaches are being used: controlled training of plants, intraspecies hybridization with consideration of selectivity of gametes in the pollination process, intergeneric hybridization (crossing wheat with couch grass and rye, with development of bigeneric and tri-generic hybrids), vegetative hybridization of grains, development of polypoid forms. Physical and chemical mutagens are also used extensively to obtain initial breeding material.

However, with all of the diversity of forms obtained by the last two methods, as yet, it has not been possible at the Institute to develop varieties superior in signs and properties to those already allocated to rayons and holding much promise, which have been developed here by the main breeding methods (hybridization and selection, as well as controlled alteration of the nature of plants). Therefore, while we have noted the positive signs of material selected for initial breeding, created under the influence of various mutagens, and by using polyploids, the development of new forms by these methods may merely be interpreted as the first preliminary stage of this work. They cannot replace hybridization and selection, and must supplement them in the capacity of elements of the same selection process.

It is to be hoped that in the future, with inclusion of these forms in hybridization, and with appropriate training and selection, the new initial material for hybrid progeny will be found useful in the development of new and valuable varieties of agricultural crops.

The breeders at the Institute are using different methods, combining them in a single selection process, which provides the conditions for creative competition and allows for evaluation of a given method according to the efficacy of the results.

All of these investigations are associated with theoretical and methodological research work oriented toward comprehensive investigation, in particularly, of the process of pollination. For this purpose, in a number of laboratories, there are specialists proficient in cytophysiological research methods.

Scientists in adjacent disciplines: physiology, biochemistry, phytopathology, entomology, technology, are also collaborating with breeders in the development of new, valuable varieties of agricultural crops. The highest effectivity of selection work can be achieved only through such coordinated work by these scientific workers.

It is necessary to create the proper conditions in scientific groups for the creative competition among scientists following different methods, while practice must be the criterion of the validity and reliability of each method, evolving from the different theoretical positions, from the standpoint of what it actually contributes to agriculture, to the collective and state farms. The untiring search for new and more effective ways of increasing the productivity of agriculture on the basis of progress in biological science will undoubtedly make a great contribution, but theoretical and practical.

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